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THE SOCIAL SCIENCES AND NATIONAL PLANNING[1]

By Professor WESLEY C. MITCHELL

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AN impression prevails in many minds that social science has made out a case against national planning, at least in economic matters. This impression is the vestigial remnant of what used to be a vigorous belief. English political economy arose as a destructive critique of the national planning done by mercantilist statesmen and as a constructive argument for a policy of *laissez-faire*. But since Adam Smith published "The Wealth of Nations" in 1776, economic practise and economic theory have been evolving rapidly, each acting continuously upon the other. Present opinions upon national planning are the outcome up to date of these historical developments in the field of practise and of theory, which I shall sketch as briefly as I can.

I

The aim of mercantilist planning was to mobilize economic forces for national aggrandizement. The country should have a numerous population; the common people should be trained in husbandry and the crafts, inured to labor and kept from the consumption of luxuries that are merely pleasant, such as sugar and tea. The necessaries of life should be produced at home as a precaution against foreign attack; the mercantile marine should be fostered as an auxiliary of the navy; an abundant supply of the precious metals is desirable both for home trade and as the sinews of war. To guarantee this supply countries that have no mines of gold and silver must see that the balance of trade is "favorable." To that end, exports should be encouraged, and imports discouraged, except in the case of commodities destined for resale abroad or of raw materials for domestic manu-

[1] Address as retiring chairman and retiring vice-president of the Section for Social and Economic Sciences, American Association for the Advancement of Science, Pittsburgh, January 1, 1935.

factures. Private enterprise should be directed toward industries that the government is trying to develop on national grounds; colonies should get most of their manufactured goods from the home country and send raw materials in return; foreign commerce should be supervised to make sure that merchants comply with the national plan.

Of course this scheme of statecraft involves national economic planning of an elaborate, continuous sort, calling for eternal vigilance on the part of statesmen and tending to develop into detailed regimentation of economic life. The occupation a youth may choose, the apprenticeship he must undergo, the wages he may receive, the places in which he may live and work, the commodities he may consume, the products which his master may make, the technical processes to be followed, the standards of materials and workmanship to be observed—these are but samples of the matters which mercantilism sought to control in its heyday.

This type of national planning grew up as centralized states emerged from the confusion of feudalism, and prevailed with numberless variations of detail over Central and Western Europe for two or three centuries.[2] At many points, the mercantilist regulations stood in the way of enterprising money makers, or even created opportunities to make money by breaking the law—for example, by smuggling. Hence the system tended to break down in detail whenever the administration of the laws grew lax for any reason. Certainly in England and her colonies, private disregard of mercantilist regulations became a mass phenomenon in the eighteenth century. Nor did the authorities try hard to stop all infractions of the law. One may say that *laissez-faire* was practised on a considerable scale before it was preached as a formal doctrine.

Adam Smith was not the first, but he was the most effective critic of mercantilist planning. His argument can be summed up in a syllogism: first, every individual desires to increase his own wealth; second, every individual in his local situation can judge better than a distant statesman what use of his labor and capital is most profitable; third, the wealth of the nation is the aggregate of the wealth of its citizens; therefore, the wealth of the nation will increase most rapidly if every individual is left free to conduct his own affairs as he sees fit. There need be no fear that consumers will be exploited under such a system; competition among producers is a sufficient safeguard against that danger. To make gains for himself each producer must offer goods which others want at prices set by competition. Thus, in pursuing his own gain, every producer is led to promote the public interest.

By formulating this argument with the authority of a moral philosopher, Adam Smith offered his contemporaries a justification of acts which thousands had been performing with a bad conscience. The "rationalization" lent new vigor to private disregard of hampering regulations and so contributed toward the breakdown of mercantilism. It is hard to-day to realize how Adam Smith clarified the minds of men and lifted their hearts with his ringing call to adopt "the simple and obvious system of natural liberty." His was a great service to blundering humanity during the difficult transition that lay so near at hand. And that service was accepted with a promptness which has few parallels in the history of thought. Far more rapidly than he had supposed possible, Adam Smith's views were adopted by other thinkers, by business men and by statesmen. Supplemented by the philosophical radicalism of Jeremy Bentham and his disciples, restated to fit changing conditions by later economists, *laissez-faire* became the dominant maxim of British economic policy and exercised a powerful influence upon thought and action throughout the western world. We may almost say that for two generations the British government planned to to have no plan.

II

Economists no longer celebrate "the simple and obvious system of natural liberty" after the sweeping fashion of Adam Smith. Social organization has become vastly more complex than it was in the eighteenth century; business planning and government planning have become closely intertwined with one another; discussions of their rôles in guiding economic activities now deal with the diversity of conditions produced by a century and a half of the industrial revolution.

Even while they were in process of assimilating the doctrine of *laissez-faire,* the English people began using their government as an agency for correcting what they thought to be bad results of private enterprise. Some of these governmental controls could be defended by a shrewd interpretation of Adam Smith's logic. Thus laws to protect child workers and presently laws to limit the hours worked by "young persons" and women could be defended on the ground that minors and women of any age were not in fact the best judges of what is good for them. Public opinion came to believe that it was foolish to permit even grown men to take the risks of overloaded ships, unfenced machines, ill-ventilated mines, or occupational diseases, however accustomed they might be to do so, and successive parliaments passed laws to re-

[2] Any brief sketch of mercantilist policies must be schematic to a degree. The present sketch is probably least misleading as a representation of the policies which Colbert sought to carry out in France.

duce industrial hazards of many sorts. If the mass of the wage-earners were as blind to their economic interests as the Malthusian principle of population represented them to be there was reason for tutelage in many matters. Compulsory education came to seem an obvious need. The industrial revolution called for operatives who could read blueprints and clerks who knew arithmetic. Democracy, the political complement of economic liberty, demanded literate citizens. Accordingly, the government went much further than Adam Smith recommended in providing education at public expense and forcing parents to accept it for their children. Adam Smith had justified state provision of public works; the list of such works grew with the density of population and scientific knowledge of public hygiene. The rise of the gas industry, of railroads, of tramways, of the telegraph, the telephone, electric lighting and power transmission built up a great class of public utilities midway between the fields of private enterprise and public works. These utilities could not serve the public cheaply and efficiently under such competitive conditions as worked well in manufactures and trade; they were "natural monopolies," and as such they could be subjected to special regulation, or even owned and operated by governments that professed the doctrine of *laissez-faire*. Presently, it began to appear, though more strikingly in the United States than in Great Britain, that in many industries competition was breeding combinations. The joint-stock company, which Adam Smith had thought of as limited by its own competitive inefficiency to a brief list of trades requiring vast capital rather than active enterprise, proved admirably adapted to the factory age with its heavy investments, once the principle of limited liability had been accepted. Incorporation made it easy to organize business enterprise in units large enough to dominate whole industries. Once more, government intervention could be justified on familiar grounds. Adam Smith had taken it for granted that the consumer, for whom he felt tender solicitude, would be protected against exploitation by competition among numerous producers. If that was ceasing to be the case, it seemed logical that government should break up the monopolistic corporations and force the fragments to compete again.

So far I have mentioned governmental actions intended to remedy what were thought to be bad results of business planning or to supply social needs for which business planning made no adequate provision. I go on to list various shortcomings of business planning that are troubling our minds to-day, shortcomings which government is often called upon to correct or to supply.

A specter that has troubled men's minds more and more as the industrial revolution makes headway is the rapid depletion of natural resources. In 1865 W. Stanley Jevons pointed out that the fixed limits of coal deposits made it impossible that Great Britain should long maintain its current rate of increase in industrial output. Somewhat later Americans began to feel apprehensive about their supplies of lumber, natural gas, oil and other minerals. Now we are becoming dimly fearful about the loss of soil fertility through reckless methods of cultivation and erosion. The appalling wastes of natural resources that are going on seem due largely to the policy of handing over the nation's heritage to individuals to be exploited as they see fit. It appears that business planning takes and must take a relatively short period of time into account—a period that is but as a day in the life of a nation. What is rational on the basis of this short-run private view may be exceedingly unwise on the basis of long-run public interest. We see now how vital a factor Adam Smith overlooked in taking the nation's wealth as the aggregate of the wealth of its individual citizens. And what can be said about the wasteful use of natural resources by private enterprise can be repeated with increased emphasis regarding the use of human resources. Private enterprise draws thousands of youths into "blind-alley" occupations from which they emerge little fitted to assume the responsibilities of mature life. The work it provides for millions of adults fails to make use of their full capacities and leaves many the victims of "balked dispositions." We have allowed our immediate economic interests to lead us into modes of living which fail to satisfy our emotional needs and our creative impulses.

Experience is showing also that, great as are its contributions to social welfare, business planning has a formidable array of technical limitations of which we are becoming increasingly conscious as the years pass and as our ideas of what is possible to mankind grow more daring.[3]

Business planning can secure effective coordination of effort only within the limits of each independent business enterprise; that is, each group of business activities subject to a single financial control. It can not effectively coordinate the activities of independent enterprises.

Coordination within an enterprise is the result of careful planning by experts; coordination among independent enterprises cannot be said to be planned at all—rather it is the unplanned result of natural selection in a struggle for business survival. Coordination within an enterprise has a definite aim—the making of profits; coordi-

[3] In the following five paragraphs, I venture to reproduce with minor changes passages which I contributed to the "Report of the National Resources Board," pp. 81, 82. Washington, Government Printing Office, December, 1934.

nation among independent enterprises is limited by the conflicting aims of the several units. Coordination within an enterprise is maintained by a single authority possessed of power to carry its plans into effect; coordination among independent enterprises depends on many different authorities which have no power to enforce a common program, except so far as one can persuade or coerce others. As a result of these conditions, coordination within an enterprise is characterized by economy of effort, coordination among independent enterprises by waste.[4]

The planning of business enterprises aims at making money. If the ultimate test of economic efficiency is that of satisfying the most important social needs in the most economical manner, then business planning must be warped by inequality in the distribution of income. Where a few have money enough to gratify almost any whim and where many can not buy things required to maintain their efficiency or to give proper training to their children, it can hardly be argued that the goods which pay best are the goods most needed.

From the view-point of business itself, planning to make money is a precarious undertaking that often ends in heavy losses or financial ruin. However skilfully the internal affairs of a corporation are managed, the whole venture may be wrecked by circumstances beyond the control and even beyond the knowledge of the managers. As markets grow wider, investments heavier and financial interrelationships more complicated, it becomes harder for the ablest management to anticipate the conditions which the next few years will bring forth. The movement toward business combinations is largely a business man's remedy for uncertainty—his effort to extend the number of factors which he can control. But combination by one group of enterprises increases the hazards for other enterprises. It is not surprising that with growing frequency business men have turned to the government for aid and demanded that it protect them against hazards which they can not control, including the hazard of combinations among other business men.

The frequent recurrence of economic crises and depressions is evidence that the automatic functioning of our business system is defective. In view of recent events no one longer holds that the business cycle is being "ironed out." Instead, it appears that the difficulty of maintaining the necessary equilibrium among different factors in the enormously complicated mechanism is becoming greater rather than less. Aside from the widening of markets and the growth of combinations mentioned above, we face the fact that an increasing part of the annual output consists of semi-durable goods which people can stop buying for a time if times are bad. The drift of population from farms to cities and the diminishing dependence of farm families upon what they can make for their own consumption, their increasing dependence upon selling farm produce to get the wherewithal for buying other goods, mean that general economic maladies afflict more people more seriously than they did in past generations. Business planning has found no effective means of preventing the growth of these factors that tend to make the business-cycle hazard more serious.

When a grave depression occurs, recovery is retarded by the divergence between the policies followed by powerful corporations in highly organized industries and the policies that are forced upon small producers in simply organized industries, of which farming is much the most important. Formerly, when a depression came, prices fell in almost all markets. This decline proceeded until the resulting checks upon production and stimulations of purchasing produced a new equilibrium between the demand and supply of most commodities at prices lower than those prevailing during the preceding phase of expansion. Then business activity began to pick up again. The revival came about automatically: business men had merely to look after their individual interests, and government to remain a passive spectator, or at most to increase its allowances for the support of the poor. Of late, this automatic process of recovery has become less prompt and effective. The managers of great corporations usually believe that the best way to minimize their losses during a depression is to maintain prices, despite the heavy falling off in sales and production which is likely to follow. That policy will at least cut down the heaviest items of current expense —cost of materials and wages. But farmers, who individually can exercise no control over the prices of their products, must continue to produce as much as they can and to sell for what they can get in a community where many consumers have lost their jobs. Because their incomes are cut by low prices, the farmers can not buy freely from the corporations that are keeping their prices relatively high. Because farmers, other small producers in a similar position and their former employees who are now out of work can not buy freely, the rigid-price corporations have small inducement to increase output and put men back to work. Recovery under such conditions is a far slower and more halting process than it was when all prices were flexible in much the same degree.

If business men are justified in demanding that government take measures to protect them against the hazards of trade, how much stronger justification for

[4] See Wesley C. Mitchell, "Business Cycles: The Problem and Its Setting," p. 172. National Bureau of Economic Research, New York, 1927.

such a demand have wage-earners! The day when it was plausible to argue that steady work comes to steady workmen is past. Sobriety, industry, thrift will not enable a man to keep his job if the company which employs him shuts down. Nor is it his fault if he can not get a new job promptly when there are ten applicants for every opening. Cyclical unemployment is the labor side of the business-cycle hazard, and, as said above, that hazard is not shrinking. Technological unemployment is the labor side of industrial progress and that hazard is growing. Economic security for wage-earners, much the most numerous class of people in a commercial nation, certainly has not been provided by business planning.

Finally, we are often told nowadays that, even in the best of business years, our present economic organization prevents us from making full use of the technological skill we have attained and of the capital we have accumulated. As a rule, statements of this sort are vague and sweeping, better calculated to arouse interest than to convince a skeptic. But recently two efforts have been made to get more definite ideas about the margin by which actual production at the peak of prosperity falls short of what production might be if we could make full use of our facilities. In 1933, twenty-eight engineers of experience in various industries were persuaded to submit estimates of how much the aggregate output of all industries might be increased simultaneously with existing equipment and methods, provided a ready market could be assured for the products. More than half of the estimates ran above 25 per cent. Asked what increase might be expected if the equipment and management of all industries were "brought to the level of the best current practise" half of the engineers gave estimates of 60 per cent. or more. Second, an elaborate statistical study of the proportion of the country's capacity for production that was utilized in 1925–29 has yielded similar results. The conclusion drawn was that, taking the full gamut of operations from agriculture and mining, through manufactures and transportation to retail distribution, it would have been feasible to produce nearly 20 per cent. more goods than we did by the methods then in use and with the equipment and labor we then possessed.[5] Thus the charge that our economic organization fails by a wide margin to secure the full use of our productive capacity even in years of business activity is sustained by both of these inquiries. An increase of a fifth or a quarter in the national income above the highest levels yet attained seems to be technologically feasible merely through fuller use of the equipment and methods in use. If the engineers are right, these increases might be doubled or trebled by bringing equipment and management in all enterprises abreast of the best current practise.

To draw up a list of errors and omissions under business planning is not to damn private enterprise. Few dispositions seem to me more misguided than the disposition to regard business as a monster which prevents suffering humanity from attaining its heart's desire. After all detractions are made, the historical fact remains that, in the countries which have given wide scope to private initiative since Adam Smith presented his momentous argument for *laissez-faire*, the masses of mankind attained a higher degree of material comfort and a larger measure of liberty than at any earlier time of which we have knowledge, or under any other form of organization which mankind has tried out in practise. These blessings of relative abundance and freedom arise from the rapid application of scientific discoveries to the humdrum work of the world, and that application has been effected mainly by men who were seeking profits. In societies organized on the basis of making money, *laissez-faire* put the stupendous drive of private gain behind the industrial revolution. Further, the capital required for building machines, factories, railroads, steamships, electrical equipment and the like was accumulated mainly from profits made by business men and investors and used, not to satisfy their own wants, but to provide new equipment for production. As Adam Smith argued, in pursuing their private gain business men were led to promote the public welfare.

III

Yet no class in the community has been satisfied with the workings of private initiative. From capitalists to farmers and working men, all of us have tried to use government as an agency for bettering economic organization. The way in which government should be used has been the central issue of our political struggles more often than the question whether government should be used at all. For few of us have been willing to trust what Adam Smith regarded as "natural" forces. Instead, we have cherished ambitious designs of harnessing social forces much as we have harnessed steam and electricity.

Nor have these attempts been fruitless. The familiar contrast between the rapid industrial progress since James Watt invented the separate condenser and the slow social progress since Watt's friend Adam Smith published the "Wealth of Nations" is often exaggerated. England in 1934 is a very different society

[5] See "Economic Reconstruction," Report of the Columbia University Commission, pp. 87–104, New York, 1934; Edwin G. Nourse and Associates, "America's Capacity to Produce," pp. 415–425, Washington, 1934.

from the England of 1776, and the difference is not limited to technology. For example, the working-class babies of this year will have educational opportunities which were closed to their ancestors; their choice of occupations will be wider; they will work fewer hours; their livings will be more secure; they will dwell in less hideous and more healthful towns; fewer of them will be maimed at work or contract occupational diseases; their span of life will be longer; they will be free to unite with their fellows in promoting their common interests; they will have a share in governing their country. These advantages they will owe to the long series of social reforms which have been enacted one after another, and which these babies of 1934 will have a better chance to extend in their turn than had the working-class babies of 1776.

But considerable as the advances effected in social organization during the last century and a half have been, the pace has been less rapid in this field of effort than in the field of industry. To explain this cultural lag is not difficult.

First, the social sciences which are needed to guide efforts to control social forces are less precise and dependable than the natural sciences which guide efforts to control natural forces. That difference in the character of man's knowledge in these two fields is due to the vastly greater complexity of social phenomena, and to the conditions surrounding research in the two fields. In the one field experiments can be tried within the limits set by expense; in the other field experimentation is not wholly barred, but it is narrowly restricted.

Second, applications of social science to practical affairs rarely promise a personal profit to the innovator. At most he may dream of being honored by his fellow men.[6] Still more rarely can a second advance be financed from the proceeds of past successes. Thus the drive of profit, which gave such energy to the industrial revolution, has not pushed forward the social revolution. The Communist Manifesto told the workers of the world in 1848 that they had "a world to gain" by uniting; but this vague incentive to millions was a less effective spur to action than the concrete prospect of profits to individuals. And now that the workers of one country have captured the government and begun an experiment in communism, the workers of other countries seem inclined to wait for the gains to materialize before imitating the Russian example. Also the process of initiating industrial improvements is far simpler than the process of initiating social improvements. Any innovator who could command a modest capital might adopt what he believed to be an industrial improvement without more ado. If his faith proved justified, he could coerce his competitors to follow his example under penalty of commercial ruin. The innovator who wants to secure what he believes to be a social improvement must convince many men before he can secure a trial of his plan, and for convincing men he must rely upon persuasion. More commonly than not, the projected change threatens some vested interest, and the would-be reformer's campaign of education has to meet a well-financed counter campaign. The social innovator can not coerce anybody until he has won government; the industrial innovator brings coercion to bear upon his competitors as soon as he begins to undersell them. Finally, experiment plays a rôle in the applications of science not less important than its rôle in scientific discovery. Again the advantage is all on the side of the natural as opposed to the social sciences, of industry as opposed to social organization. Social like mechanical inventions are usually crude at first; both types need to be perfected in detail before they will work well. In industry this process of improving upon the original design is facilitated by practical trials on a small scale before large risks are taken. In social organization similar experimental runs are sometimes feasible; but often that is not the case. Nations must try many innovations upon a large scale or not at all; the crudities of the first plan must be discovered at heavy cost and eliminated by a process almost as halting as the process of inducing government to make the first venture.

[6] Of course this remark does not apply to all efforts to secure governmental action. The advocates of a tariff bill, for example, may expect and achieve substantial profits. But legislation promoted for private gain is seldom an application of social science to practical affairs.

IV

Beset by so many difficulties, social planning has run a most uncertain course during the last century and a half, while the industrial revolution has been marching forward. In England and the United States most of the attempts to use governmental agencies in new ways have been piecemeal efforts started by private citizens to remedy some single bad situation. Philanthropists have played the leading rôles in many of these efforts; in others, groups that felt themselves aggrieved or oppressed have provided the spokesmen. To get what they wanted, these leaders have had to use the arts of propaganda and organization directed to the one specific aim in view. England has produced two great groups of thinkers who developed systematic programs of social reorganization—the Philosophical Radicals in the opening decades of the 19th century and the Fabian Socialists in the closing decades; but in so far as their plans have been carried out, it has been on the empirical

basis of one thing at a time and mainly through men who did not count themselves members of the groups in question. In this country it is hard to find even one group of systematic planners to set beside the Benthamites and the Fabians.

A less numerous but more imposing class of national plans are those that have been drawn by governments to meet grave emergencies. The most striking examples are the economic mobilizations effected during the world war and the efforts of President Roosevelt's administration to cope with the great depression. Other governments have been bolder in trying to change the social organizations of their peoples. Perhaps the most demonstrably successful case of systematic government planning which the world offers is that of Japan. When the Shogunate was abolished and the Mikado was restored to power in 1867, the responsible statesmen of the country deliberately undertook to transform their feudal realm into a modern commercial state with the standard accompaniment of military power. How rapidly they have progressed toward this end within the short space of two generations every one knows. Bismarck's plans for German development are the most notable European achievements of pre-war days in constructive government planning. Of course we can now add to the list the grandiose experiments of communism in Russia and of fascism in Italy.

Both types of planning that have prevailed in this country—efforts to solve one problem at a time and efforts to meet national emergencies by quick action—have grave defects. The piecemeal method overlooks the interdependence which is so important a characteristic of social processes. Change one feature of social organization and you are certain to change many other features also. Some of the changes you did not plan you will not like. For illustrations, recall the results that flowed from the thirteenth amendment to the constitution abolishing slavery and from the eighteenth amendment that sought to abolish the liquor traffic. It is only by very careful study of the social situation as a whole that changes can be made with a maximum of beneficial and a minimum of harmful effects. As for emergency planning in the face of impending disaster, it is certain to be defective in many ways just because there is not time enough to use what wisdom we have.

Critics of both the piecemeal efforts of reformers and of the inspirational efforts of statesmen acting in a hurry can make out a strong case against much if not most of the national planning we have done in this country. But any one who attempts to check the practise of national planning will argue in vain. So long as men have power to think, private citizens will go on devising plans for what they find amiss in social organization, and some of their plans will win general approval. Also, so long as we continue to encounter national emergencies from time to time, our government will go on adopting hurried measures. The course of wisdom is not to oppose national planning, but to make that planning more intelligent. The more clearly any man grasps the enormous difficulties of the task, the more sharply he realizes the harm done by poor planning, the keener he should be to promote intelligent plannning: for national planning of some sort, or rather of many sorts, we are certain to have.

The two great improvements needed in American planning are recognition of the interrelationships among social processes and preparedness to deal seriously with social problems before they have produced national emergencies. It is possible of course that our future reformers will have a wider field of vision than their single-eyed predecessors. It is possible, also, that our government in future will be more alert to coming troubles even when times are good. Let us hope so. But may we not also set ourselves to organize our intelligence for a systematic consideration of social problems and how they may best be solved?

An organization devoted to these aims we have never had; for no President and cabinet can take time from their pressing executive duties for systematic long-range planning. Such planning is a task that demands the full time and energy of the ablest men in the country. And the abler these men, the more eager they would be to secure the services of a varied technical staff and the counsel of a wide circle of advisers. Indeed, a competent National Planning Board would conceive itself, not as depending upon its own wisdom, but as an agency for focussing the intelligence of the nation upon certain issues, in the hope of formulating plans that would command sufficient confidence among their fellow citizens to be given trials. It is only as an advisory body that such a board would fit into the American scheme of institutions. A large part of its task would be to draw the line between cases in which government should seek to exercise control and cases in which private initiative should prevail. To preserve the effective liberty of the individual in the modern world requires national planning of as shrewd and elaborate a sort as the planning required to check abuses or to supply lacks. Indeed, it is only by preventing one group of citizens from exploiting other sets and by supplying those services which private enterprise can not render that individual liberty can be secured.

How much a National Planning Board with advisory powers might improve upon our efforts to solve social problems by taking thought no one can tell in advance. What I have said about the difficulties which beset the social sciences warns us that suc-

cess is not a foregone conclusion. To supply deficiencies in knowledge the board would doubtless have to undertake much research through its own staff or through other agencies. But after doing its best to lay a scientific foundation for its plans, the board would often have to advise proceeding in an experimental fashion on the basis of probabilities. It would be doing pioneer work; for it would be trying to better the social organization of one of the most advanced countries in the world—to do things which have not yet been done. Hence it could not expect to achieve as brilliant a record as did the elder statesmen of Japan, who were seeking to pull abreast of other nations and so had models to imitate. And of course the usefulness of the board could be wrecked by the appointment of men chosen for partisan reasons. Or a board of men possessing technical competence but lacking in other qualities might antagonize the Executive, Congress and the public, and so lose its influence. Perhaps the idea of trying to mobilize the intelligence of the country for systematic and continuous study of social problems will be rejected by public opinion. But it would seem that we have had enough experience with reforms that produce almost as much harm as they remove to be willing to try a more scientific method of dealing with social problems.

SCIENTIFIC EVENTS

THE AGRICULTURAL PROBLEMS OF MEXICO

THE special correspondent of *The Christian Science Monitor* writes from Mexico City that the 35,829,500 acres of arable land can not be cultivated until the population has reached at least 30,000,000 inhabitants. This statement, made in a recent study by A. Lozcano, agricultural engineer, and regarded as an argument that Mexico should let down its immigration bars, followed closely upon the recent publication of a symposium by a group of Mexican technicians, of which Señor Lozcano was one.

The symposium, entitled "The Agricultural Problem of Mexico," according to the correspondent, was issued at a time when other effects of Mexico's preoccupation over problems of population and their relation to more organized and efficient production were beginning to show themselves.

One instance was the announcement of plans for the founding of ten new cities on different irrigation systems, and another the continued pace at which commonland-grants are being parceled by the government, a total number of 7,141 peasants having been provided with such parcels during the month of September.

The problem of improving means and methods of better cultivation are said to have been greatly exaggerated in Mexico. That phase of the question is secondary compared with that of increasing the agricultural and national population.

The ten cities to be constructed by the National Irrigation Commission on as many national irrigation systems in different parts of the country will represent a total outlay of about 5,000,000 pesos, or an average of 500,000 pesos each.

The new centers will be modeled after the agricultural city, Anahuac, built last year on National Irrigation System No. 4 in the northern part of the country, and which now has a total population of about 5,000. They will include complete water, drainage and light systems, well laid out streets, office buildings, shops, warehouses, post office and telegraph service, branches of agricultural banks for colonists and common land-grant owners and hotels.

The purpose of the new cities is to provide a more comfortable way of living for the thousands of colonists and to give them the benefit of more modern social and educational advantages.

When work now being carried on at different systems is concluded, 728,945 acres of land will be under cultivation. Every system has its chain of highways and roads connecting it with important distribution centers. According to the report, the efficiency with which this work has been carried on and the systems put to practical use are superior to those shown by similar services in other countries.

Plots are obtained by immediate payment in full, or by promise-of-sale contracts of two types, short and long-term—the latter covering a period of from 24 to 25 years.

THE LINDBERGH COLLECTION OF SPORES IN ARCTIC AREAS

COLLECTIONS of micro-organisms which Colonel Charles A. Lindbergh made on his flight through the Arctic areas in the summer of 1933 are described in the January issue of *The Scientific Monthly*, by Fred C. Meier, senior agriculturist, U. S. Department of Agriculture, with field notes and material by Colonel Lindbergh. Mr. Meier has been studying air-borne organisms for several years—particularly those that drive northward over the plains each year to spread rust in the wheat fields. He interested Colonel Lindbergh in making this contribution to the scientific work of the department, and together they worked out new and improved apparatus for taking samples of the micro-flora of the Arctic air.

Colonel Lindbergh devised a spore trap which he

called "the skyhook," a light, strong contrivance, easy to operate, and well adapted to protecting the sterile glass slides from contamination except for the time they were exposed. Mr. Meier prepared the slides and has examined and photographed them. He credits Colonel Lindbergh with careful and painstaking work and says that "Colonel Lindbergh's knowledge of pure-culture technic made him thoroughly aware of the necessity of developing a trap that could be used with minimum danger of error resulting from contact with dust in the cockpit."

In his flights between the American mainland and Denmark, by way of Greenland and Iceland, Colonel Lindbergh exposed 26 slides and returned them with field notes and free-hand maps indicating exactly where and for how long, and under what conditions each slide had been exposed. Mr. Meier has taken care of the preservation of the slides and has examined and photographed representative sections. He has been able to identify the genus and in some cases the species of many of the objects trapped in the petroleum jelly which covered the slides. More complete identifications will in many cases have to await the assistance of botanists familiar with the characteristics which identify various kinds of pollen, and of scientific workers who are specialists in different groups of fungi, mosses and lichens. On one slide, exposed far north of the Arctic Circle, Mr. Meier was able to discover under the microscope more than 40 different types of objects in a space five centimeters square. This was on a slide exposed 3,000 feet above sea level along the northeastern coast of Greenland.

Mr. Meier and other Department of Agriculture workers, assisted by Army, Navy and Coast Guard flyers, have done a considerable amount of aerial work in trapping spores and other micro-organisms, but this has been overland and in places where it was to be expected that the catch would be abundant. "This Lindbergh collection," according to Mr. Meier, "is the first of its kind to give concrete evidence of the part played by air currents in the distribution of fungi between northern lands." He points out the possibility that a single living spore which is transferred by the air currents and dropped in a spot favorable for reproduction might create a center for rapid spread of infection.

GRANTS IN AID OF RESEARCH ADMINISTERED BY THE NATIONAL RESEARCH COUNCIL

THE National Research Council has been informed that the Rockefeller Foundation has appropriated $80,000 to the council to be used for individual grants in aid of research in the natural, medical and mathematical sciences during the ensuing three-year period, 1935–37. This fund is available for use in grants of moderate size (usually less than $1,000) for the purchase of apparatus, materials and supplies, for employing technical assistance, and for field expenses. In general grants will not be made for personal services or fellowship stipends, for expenses of publication, for the purchase of books, for travel to attend scientific meetings, or for the research work of students under instruction. In the awarding of grants preference is ordinarily given to the support of investigations (a) in which the problem itself and the methods to be employed are clearly stated and in which definite results can be expected with the aid of a single grant and (b) toward the prosecution of which the university or other institution also contributes financially or through other special support. The fund is administered by a special committee of the Research Council composed of the chairman and the treasurer of the council, together with the chairmen of the council's seven divisions of science and technology.

Applications for grants to be made this spring should be submitted before April 1, 1935. Correspondence should be addressed to Dr. C. J. West, secretary, Committee on Grants-in-Aid, National Research Council, 2101 Constitution Avenue, Washington, D. C.

During the past five years the Rockefeller Foundation has appropriated to the National Research Council sums for individual grants and for conferences totaling $370,000. From these sums 638 grants have been made for the support of individual investigations and for conferences for the construction of research programs or for the coordination of research on special subjects.

ISAIAH BOWMAN,
Chairman

ANNUAL MEETING OF THE METALLURGICAL ADVISORY BOARD

REPORTS on metallurgical investigations made at the Carnegie Institute of Technology during the past year will be given by a group of investigators at the eighth annual open meeting of the Metallurgical Advisory Board to be held at the institute on Friday, February 8. Approximately 400 metallurgists are expected to attend the meeting.

Dr. John Johnston, director of the department of research and technology of the U. S. Steel Corporation, will preside at the morning session, and Dr. Frank N. Speller, chairman of the Advisory Board, will give the address of welcome.

Progress made by the Metals Research Laboratory in theoretical investigations will be reported by the director, Dr. R. F. Mehl. The various projects now being studied in the laboratory are classified under four major heads, namely, plastic deformation of metals, precipitation from solid solution, oxidation of

metals and diffusion in metallic alloys. Dr. F. M. Walters, Jr., formerly of the staff, will offer a final report on the alloys of iron, manganese and carbon, which he investigated for a period of several years at the institute.

Dr. Cyril Wells, also of the metals laboratory, will explain the preparation and properties of high purity iron and will report on a study of the constitution and properties of a pure sample. The final report of the morning session will be read by B. N. Daniloff, research fellow, on "The Effect of Deoxidation on the Aging of Mild Steels."

At the afternoon session at which H. W. Graham, general metallurgist of the Jones and Laughlin Steel Corporation, will preside, Dr. Charles H. Herty, Jr., formerly director of research for the Metallurgical Advisory Board, will report on the studies which were made under his direction.

These reports will conclude the program of research on the physical chemistry of steel-making which has been carried out for the past eight years by the Metallurgical Advisory Board. A group of prominent metallurgists from the industry will discuss the findings.

An informal dinner at the University Club will conclude the meeting. The speaker on this occasion will be J. Steele Gow, director of the Falk Foundation, who will speak on "Research in the Economic Field." The laboratories of the Carnegie Institute of Technology will be open for inspection for visitors on Saturday morning.

THE DIRECTORSHIP OF THE AMERICAN MUSEUM OF NATURAL HISTORY

AT a meeting of the Board of Trustees of the American Museum of Natural History on January 7, Dr. George H. Sherwood resigned as director to give his entire time to the School Service Section as curator-in-chief of education. Dr. Sherwood will remain honorary director of the museum. Dr. Roy Chapman Andrews, explorer and naturalist, will succeed Dr. Sherwood as the active head of the museum.

In reference to these appointments a correspondent writes:

Dr. Sherwood has been connected with the American Museum since 1902 when he became assistant curator of invertebrate zoology. From 1906 to 1911 he was assistant secretary of the museum; from 1911 to 1921, executive secretary; from 1924 to 1926, acting director. He became director in 1927.

During the years of his directorship, the museum has undergone rapid expansion. Akeley African Hall and the Whitney Hall of Oceanic Birds are well on their way to completion. A new Reptile Hall, with all the most recent methods of mounting and groupings, was opened in 1929 and the Hall of South Asiatic Mammals. Collections for the African Hall have gone steadily forward. Of the twenty-eight groups planned, half are finished or nearing completion. Last fall work was started on the new Hayden Planetarium, which will be ready in the spring. The Department of Education was conducted wholly within the museum up to 1904 when the first outside contacts were made through the distribution of nature-study collections to the schools. Since then, the school work has rapidly expanded. Last year, more than 30,000,000 contacts were made with New York school children through lectures, films, lantern slides and circulating collections. During the past few years, Dr. Sherwood has pushed the educational work further and established classes for teachers in museum instruction through cooperation with the College of the City of New York and New York University.

As leader of the Central Asiatic Expeditions of the American Museum of Natural History, Dr. Andrews took his first expedition into the field in 1916 to work in the territory of Thibet, Southwest China and Burma. His second expedition went into North China and Outer Mongolia in 1919, and the third expedition has worked in Central Asia, especially in Mongolia, since 1921, where it uncovered some of the richest fossil fields in the world. This was the largest and most completely equipped land expedition ever to be sent out up to that time.

In 1918, Dr. Andrews served in the Intelligence Service in China. He was awarded the Elisha Kent Kane Gold Medal of the Philadelphia Geographical Society previously given to only eight explorers. Brown University and Beloit College have both conferred on him the degree of honorary doctor of science. He has been given the Hubbard Medal of the National Geographic Society in recognition of his discoveries in Asia.

Dr. Andrews is well known as a lecturer and author of popular books and articles on the results of his various expeditions, including "On the Trail of Ancient Man," "Ends of the Earth," "Whale Hunting with Gun and Camera," "Camps and Trails in China," "Across Mongolian Plains," and a large volume covering his entire field work in Mongolia and China up to the present time, entitled "The New Conquest of Central Asia."

RECENT DEATHS

DR. OLIVER PEEBLES JENKINS, emeritus professor of physiology and histology at Stanford University, died on January 9. He was eighty-four years old.

PROFESSOR GEORGE LEONARD HOSMER, a member of the department of civil engineering at the Massachusetts Institute of Technology for thirty-seven years until his retirement last October, died on January 10. He was sixty years old.

DR. WILBUR GARLAND FOYE, professor of geology at Wesleyan University, died on January 8, at the age of forty-nine years.

DR. ALFRED OWRE, until his resignation in 1933 dean of the School of Dental and Oral Surgery at

Columbia University and previously from 1905 to 1927 dean of the School of Dentistry of the University of Minnesota, died on January 2 at the age of sixty-four years.

DR. FRANK STEWART KEDZIE, of the Michigan State College, died on January 5, at the age of seventy-eight years. Dr. Kedzie had been connected with the college since his graduation in 1877. He was professor of chemistry from 1902 to 1915; president from 1915 to 1921, and dean of the department of applied science from 1921 to 1927.

DR. CORNELIA M. CLAPP, since 1873 until her retirement in 1916 professor of zoology at Mount Holyoke College, and since 1897 trustee and emeritus trustee of the Woods Hole Marine Biological Laboratory, died on January 1 at the age of eighty-five years.

SIR JAMES ALFRED EWING, president and vice-chancellor of the University of Edinburgh from 1916 to 1929 and president of the British Association for the Advancement of Science in 1932, died on January 7, at the age of seventy-nine years.

A CORRESPONDENT writes: "Dr. A. Brožek, professor of genetics at the Charles University of Prague, died on November 8, at the age of fifty-two years. He had been since 1924 member and since 1930 fellow of the American Association for the Advancement of Science and was a member of the American Genetic Association. In the year 1924 he studied with Professor T. H. Morgan at Columbia University. Dr. Brožek worked on heredity and cytology in Limulus for twenty-three years and was the author of a textbook of genetics in Czech."

SCIENTIFIC NOTES AND NEWS

ACCORDING to the *Journal* of the American Medical Association, Dr. Henry Beeuwkes, of the staff of the Rockefeller Foundation, has been awarded the Mary Kingsley medal by the Liverpool School of Tropical Medicine in recognition of scientific accomplishment in research on yellow fever conducted in West Africa. At the ceremony in Liverpool, medals were awarded also to Sir George Buchanan, Sir Rickard Christophers and Sir Malcolm Watson. Dr. Beeuwkes was director of the West African Yellow Fever Commission, which studied yellow fever in Africa for nine years. During this period Dr. Hideyo Noguchi, Dr. Adrian Stokes and Dr. W. Alexander Young died of yellow fever contracted during the investigation.

PROFESSOR CHARLES A. SHULL, of the University of Chicago, was awarded the Stephen Hales Prize at the recent Pittsburgh meeting of the American Society of Plant Physiologists. Professor F. F. Blackman, of the University of Cambridge, was elected to the Charles Reid Barnes Life Membership; Professor V. N. Lubimenko, of the Botanical Garden of the Academy of Sciences, Leningrad, and Professor Gottlieb Haberlandt, of the University of Berlin, were elected corresponding members.

ON the occasion of the twenty-first annual meeting of the National Council of Geography Teachers, the Distinguished Service Award was presented to Professor A. E. Parkins, of the George Peabody College for Teachers, Nashville, Tenn. The award was established two years ago and the first recipient was the late William M. Davis, of Harvard University. Last year the award went to Professor R. H. Whitbeck, of the University of Wisconsin.

DR. ALEXANDER ZAHLBRUCKNER, formerly director of the National Museum in Vienna, has been elected an honorary member of the Linnean Society, London.

THE title of emeritus professor has been conferred by the University of London on Dr. E. G. Coker on his retirement from the Kennedy chair of civil and mechanical engineering at University College.

IT is reported in the *Journal* of the Washington Academy of Sciences that Dr. Paul R. Heyl, physicist of the National Bureau of Standards, was severely injured in an automobile accident recently, suffering the loss of his right arm.

DR. H. T. GUSSOW, Dominion botanist of the Department of Agriculture, Ottawa, was elected president of the American Phytopathological Society at the recent Pittsburgh meeting. Other officers elected were: *Vice-president,* F. C. Meier, of the Bureau of Plant Industry; *Secretary,* H. P. Barss, professor of botany, Oregon State Agricultural College; *Treasurer* and *Business Manager,* Dr. Howard A. Edson, head of the plant disease survey of the U. S. Department of Agriculture.

THE Genetics Society of America elected the following officers at its recent annual meeting: *President,* Dr. Donald F. Jones, Connecticut Agricultural Experiment Station, New Haven; *Vice-president,* Dr. P. W. Whiting, University of Pennsylvania; *Secretary-Treasurer,* Dr. M. Demerec, Carnegie Institution of Washington, Cold Spring Harbor, N. Y. Other members of the executive committee are two past presidents, Professor Sewall Wright, University of Chicago, and Professor R. A. Emerson, Cornell University.

AT the New York meeting of the American Society for Metals, B. F. Shepherd, chief metallurgist of the

Ingersoll-Rand Company, was elected president; R. S. Archer, chief metallurgist of the Chicago district of the Republic Steel Corporation, vice-president, and G. B. Waterhouse, professor of metallurgy at the Massachusetts Institute of Technology, a director.

AT the thirty-first annual meeting of the Association of American Geographers, which met under the presidency of Dr. Wallace W. Atwood at the University of Pennsylvania on December 27, 28 and 29, the following officers were elected: *President,* Professor Charles C. Colby, University of Chicago; *Vice-president,* Colonel C. H. Birdseye, U. S. Geological Survey; *Treasurer,* Professor John E. Orchard, Columbia University; *Councillor,* Professor Kirk Bryan, Harvard University, and *Secretary,* Professor Frank E. Williams, University of Pennsylvania. In the three-day session, forty-nine papers were presented. As retiring president, Dr. Atwood addressed the association on "The Increasing Significance of Geographic Conditions in the Growth of Nation States."

DR. ALEXANDER C. ABBOTT, emeritus professor of hygiene and bacteriology at the University of Pennsylvania, who will celebrate his seventy-fifth birthday on February 26, has resigned as a member of the Philadelphia Board of Health. Dr. Abbott was formerly president of the board and chief of the Bureau of Health.

WILLIAM G. BROWN, formerly assistant professor of aeronautical engineering at the Massachusetts Institute of Technology and last year chief engineer of the American Loth Company, has become a member of the department of aeronautics of the Louisiana State University.

DR. RAINER SCHICKELE has joined the teaching and research staff of the department of agricultural economics at the Iowa State College. Dr. Schickele has been conducting research for the Brookings Institution for the past six months at the college.

PROFESSOR ARTHUR ERNEST JOLLIFFE has been appointed fellow of King's College, University of London. He has been professor of mathematics in the college since 1924 and was formerly fellow and tutor of Corpus Christi College, Oxford, of which college, as well as of Jesus College, Oxford, he is now an honorary fellow.

D. Q. ANDERSON, of the Iowa State College, has been appointed research assistant at the Scripps Institution of Oceanography, the University of California, at La Jolla, to work with Dr. C. E. ZoBell in marine bacteriology.

DR. MARTHA EDITH MACBRIDE-DEXTER, of Sharon, Pa., has been appointed secretary of health in the cabinet of Governor George Earle, of Pennsylvania. She took office on January 15.

DR. WALTER REGINALD BETT, of the Royal College of Surgeons, London, has been appointed librarian of the Columbia University Medical School to fill the vacancy caused by the death in October of Alfred L. Robert.

MR. WALTER O. FILLEY, forester of the Connecticut Agricultural Experiment Station at New Haven, has been elected chairman of the Connecticut Committee on Dutch Elm Disease. Mr. Filley has also been appointed station representative to cooperate with the federal crew working on Dutch elm disease. Late in December Governor Cross approved an order, drawn up by Director William L. Slate, establishing two zones of infection in Connecticut and giving federal men permission to remove dead or dying elms, as well as trees with Dutch elm disease, in these areas. In the spring the station plans to carry on an intensive survey of elms in parts of the state not covered by the federal crew.

THE *Museum News* states that D. T. Ries, formerly curator of education and entomology at the Cranbrook Institute of Science, Bloomfield Hills, Mich., is now resident at Cornell University, where he is engaged in entomological research and is working on the completion of a series of outlines of science for children.

DR. HENRY V. HOWE, of the Louisiana State University, has been appointed adviser to a geological survey of the state to be undertaken by the Department of Conservation.

DR. RANDOLPH WEST, associate professor of medicine at Columbia University, recently conducted a series of clinics and lectures before the faculty and hospital staff of the School of Tropical Medicine, Puerto Rico. A lecture on "The Relation of Pernicious Anemia, Sprue and Pellagra" was given at the annual meeting of the Puerto Rico Medical Association.

PROFESSOR HARLOW SHAPLEY, director of the Harvard Observatory, gave the Harris Foundation Lectures at Northwestern University, from January 9 to January 16. The lectures, six in number, were open to the public. The general subject of the lectures was "Exploring the Galaxies." The subjects of the individual lectures were: "The Seven-Zoned Census"; "Methods and Machinery"; "The Confusing Milky Way"; "The Clouds of Magellan"; "Galaxies-Types and Activities"; "The Metagalaxy."

DR. DONALD F. JONES, head of the department of genetics of the Connecticut Agricultural Experiment Station at New Haven, has accepted an invitation to

give the Spragg Lectures at Michigan State College, during the week of February 11. He will speak on "Genes, Present and Missing," "The Interpretation of Hybrid Vigor," "The Production of Inbred Strains of Corn" and "The Testing and Utilization of Inbred Strains of Corn."

THE fifth series of the Charles Sumner Bacon Lectures was delivered on January 16, 17 and 18 at the University of Illinois College of Medicine, by Professor Ludwig Fraenkel, head of the department of gynecology and obstetrics at the University of Breslau.

DR. HUGH L. DRYDEN delivered the address of the retiring president of the Philosophical Society of Washington on January 5. He spoke on "The Frontiers of Aerodynamics."

AT Yale University Dr. Eleonora B. Knopf recently gave, under the auspices of the department of geology, a series of six lectures on "Petrofabric Analysis," describing the technique devised by Sander and Schmidt, by which the three-dimensional arrangement of minerals in rocks is determined quantitatively.

REXFORD G. TUGWELL, Under Secretary of Agriculture, will be a speaker with Governor Lehman at the annual dinner of the New York State Agricultural Society at Albany, on January 23. Dean Carl E. Ladd, of the State College of Agriculture, will speak at the State Capitol in the morning and Lithgow Osborne will speak in the afternoon.

THE second centenary of the Spanish National Academy of Medicine, founded in September, 1734, was celebrated in Madrid from December 10 to 15.

THE General Assembly of the European Federation of Engineers' Associations will be held in Rome in May.

A JOINT meeting of the American Physical Society and the Optical Society of America will be held at Columbia University in New York City, on Friday and Saturday, February 22 and 23. Additional sessions may be scheduled for Thursday, February 21, if warranted by the number of contributed papers. In addition to the usual program of papers contributed by members there will be a joint session devoted to invited papers on atmospheric optics. The meeting will be open to non-members as well as members of the societies. A joint dinner will be held on Friday evening, followed by an evening lecture.

THE annual spring meeting of the New York Branch of the American Psychological Association will be held on April 13 at Princeton University. The general program will consist of parallel sessions running from 9:30 to 12:30 A. M. and from 2:00 to 5:00 P. M. The address of the honorary president, Dr. Joseph Jastrow, will be given in the evening following a dinner.

APPLICATIONS for telephone engineer and telegraph engineer positions of various grades in the Federal Communications Commission must be on file with the U. S. Civil Service Commission, Washington, D. C., not later than January 30, 1935. The salaries for telephone engineer range from $3,000 to $5,600 a year and for telegraph engineer from $2,600 to $4,600 a year. These salaries are subject to the usual deductions. The work will be in connection with the performance, or supervision of the performance of, engineering studies and investigations on wire telephone or telegraph systems and their component parts.

A LIMITED number of scholarships for qualified graduates in medicine who wish to do graduate study, especially in internal medicine, are available at New York Post-Graduate Medical School, Columbia University. By the terms of the endowment, applicants from Allegheny County, Pennsylvania, will be given preference, other circumstances being equal. Application should be made to the director of the medical school, 303 East Twentieth Street.

DR. C. G. JUNG, of Zurich, has presented 200,000 Swiss francs to the Higher Technical School of Zurich to form a fund for the advancement of psycho-analysis and allied studies.

SIR DOUGLAS ALEXANDER, president of the Singer Manufacturing Company, has made a gift of $10,000 to the Massachusetts Institute of Technology, of which $5,000 has been allotted to the construction of a large calculating machine for the mechanical solution of simultaneous algebraic equations. A laboratory model of the machine, which was designed by Professor John B. Wilbur, of the department of civil engineering, was recently completed. The chief use of this machine will probably be found in the analysis of stresses in various types of engineering structures, such as buildings, bridges and airplanes. Other applications can be made in such diverse fields as surveying and psychology. The balance of the fund has been allotted to the initial equipment and operation of a new laboratory for research and testing in the field of dynamic strength of materials. This work will be under the supervision of Professor A. V. de Forest in the department of mechanical engineering, who joined the staff last October.

THE William G. Bixby nut arboretum, Baldwin, L. I., has been purchased by the Federal Government. The trees have been apportioned among the new National Arboretum in Washington, D. C.; the Forest Service Nursery at Troy, N. C., and the Division of Forest Pathology. In the latter division some 1,000

disease resistant chestnuts will be distributed for reforestation to replace the large number of trees which have been killed by the devastating blight along the Atlantic seaboard. The trees include black and Japanese walnuts, butternuts, sweet hickory, shagbark, shellbark, bitternut, pignut hickory, Chinese, Korean, Japanese and European and Turkish filberts and hybrids of many varieties and species. The cost of transplanting was made possible through emergency conservation funds.

UNDER the will of Mr. Reginald Radcliffe Cory, of Wareham, who died on May 12, leaving an estate of the gross value of £221,809, a substantial residue of the property is left to the University of Cambridge for the general interests of the botanical gardens. Mr. Cory directed that the income from £30,000 of the residue should be expended in the upkeep of the botanical gardens and the payment of salaries of those employed in, or in connection with, the gardens.

ACCORDING to the *Museum News*, the Museums Association of Great Britain has made the following allotments, from the Carnegie Corporation grants, to colonial museums in the Empire: one thousand pounds to the Cyprus Museum, Nicosia, Cyprus and the Barbados Museum and Historical Society, Bridgetown, Barbados; five hundred pounds to The Museum, Georgetown, British Guiana (in addition to twenty thousand pounds for library and museum extension) and to the Nelson Museum, Antigua; four hundred pounds to the Achimota College Museum, Accra, Gold Coast; two hundred pounds to the Rhodesian Museum, Bulawayo, S. Rhodesia; The Queen Victoria Memorial Library and Museum, Salisbury, S. Rhodesia; St. John's Co-Cathedral Museum, Valetta, Malta, the Library and Museum Committee, Falkland Islands, and the Museum of the Mauritius Institute, Port Louis.

A NEW journal, entitled *The Botanical Review*, edited by Drs. H. A. Gleason and E. H. Fulling, of the New York Botanical Garden, the first number of which appeared this month, has been announced. The preliminary announcement states that "No original research will be presented, but each article will collate, summarize and evaluate all recent important work on the topic." The advisory editors are: *Paleobotany:* Professor R. W. Chaney, University of California; *ecology:* Professor W. S. Cooper, University of Minnesota; *anatomy:* Professor A. J. Eames, Cornell University; *mycology:* Professor R. A. Harper, Columbia University; *taxonomy:* Dr. F. W. Pennell, Philadelphia Academy of Natural Sciences; *cytology:* Professor L. W. Sharp, Cornell University; *genetics:* Professor E. W. Sinnott, Columbia University; *psychology:* Professor Gilbert Smith, Stanford University; *pathology:* Dr. N. E. Stevens, U. S. Department of Agriculture; *morphology:* Professor R. B. Thomson, University of Toronto, and *physiology:* Professor S. F. Trelease, Columbia University.

THE program of the fifty-third course of popular medical lectures being given by Stanford University School of Medicine on alternate Friday evenings, from January 4 to March 15, is as follows: "Brain Activities," Dr. James M. D. Olmsted; "Poliomyelitis," Dr. Harold K. Faber; "Dinitrophenol in the Control of Obesity," Dr. Maurice L. Tainter; "Quinine: The First Hundred Years," Nathan Van Patten, director of University Libraries; "Present-Day Relationships Between Medicine and Industry," Dr. William P. Shepard, and "Growth and Development in Infancy," Dr. Mary H. Layman.

DISCUSSION

THE DUTCH ELM DISEASE, GRAPHIUM ULMI, IN CONNECTICUT

THIS fungous disease was first found in Connecticut in the fall of 1933. A short account of it, up to the first of April, 1934, was published in Bulletin 358, page 305, of the Plant Pest Hand Book of Connecticut. Since then the finding of over 50 infected trees in the state and especially in Old Lyme, some fifty miles from the center of the infected area near the New York state boundary, from where the fungus apparently first spread into Connecticut, has aroused outside interest. Information concerning the disease and its control, therefore, has been requested, especially from the New England states.

A good many people believe that if the disease is not eradicated in Connecticut it will spread generally throughout New England, where many of the most valuable elms in this country are found and cause serious injury or death of the same. Certain of these people also believe that Connecticut, with its fewer infected elms and with a quicker start for control after its discovery than was the case in New York and New Jersey, has a better chance to stop its further spread into new territory to the east and north.

So far the only method tried by the government or the states, for either eradication or control, is the cutting down and burning of infected elms. Just how effective this will finally prove remains to be seen. So far, judging from results obtained in New Jersey, it does not seem to be entirely efficient either as regards cost or control, since large sums of money have been spent and there were still left standing at the

end of 1934 more infected trees than those known to have been infected at the end of 1933, despite the many trees removed in both 1933 and 1934. No one knows, moreover, how many undiscovered trees became infected in 1934 in New Jersey, New York and Connecticut; in fact, it seems that effort, so far, has been to follow up the disease at a slower rate than it advanced ahead of the control method applied.

As a result of our studies and experience with this and other tree diseases, the authors of this article believe that the time is now past when either this fungus or its insect carriers can be eradicated in the United States. We are, furthermore, of the opinion that the general destruction of infected trees and those dead or dying from other causes in the infected region of these three states and especially of forest trees, particularly in swampy land, may not be the best or most economical way of dealing with this trouble.

We believe that eventually the problem will result in a cheaper and a more practical way by limiting protection to our city, residential and highway trees. This may include better care of such trees against other injurious troubles and search for some new method for control of this one but limiting destruction of the trees, whether infected or not, until their usefulness is past their prime and especially by obtaining more complete information concerning trees sickly from other causes as to how important a factor they may be in the spread of the Dutch elm disease.

In the meantime we countenance the U. S. Government's rather ruthless and expensive plan of doubtful eradication or at best possible control by cutting down all dead and dying trees in the infected area up to the end of the summer of 1935, when more certain evidence should then finally decide how effective this plan has been. The extra money recently appropriated by the U. S. Government and that already supplied by the states, or to be supplied by them, should be sufficient to carry out this plan.

So much for general statements. The preliminary investigation of the Dutch elm disease in Connecticut, which up to the end of 1933 was entirely a matter of the botanical department, has now been assigned by the director to the departments of forestry, entomology and botany, chiefly according to their various interests.

Beginning soon after the first of August, three crews (each with two practical tree workers, previously engaged by the U. S. forces under Mr. L. R. Fate in the Greenwich-Stamford section, and each with an auto to aid in the scouting) were employed by the station to make a somewhat hurried survey of the state outside of the infected district in Fairfield County. The first of these crews took in Fairfield outside of the government surveyed area and the rest of the state east to the Naugatuck River and north to the Massachusetts line. The second crew scouted from this line east to the Connecticut River; while the third crew took the rest of the state east of the Connecticut River to Rhode Island. These crews worked until the end of September. As a result of their and the Government's inspections every one of the 169 towns of the state was visited, but only one infected tree was found outside of the known invaded area—the one at Old Lyme.

In the meantime Mr. Fate, of the U. S. Department of Agriculture, continued his careful search of the five invaded towns and their adjacent free towns in Fairfield County, but with a reduced force because of decreased Government funds. His final results for the year 1934 showed 56 infected trees in this area. Our department has verified about 40 per cent. of the elm trees, reported by the U. S. Department of Agriculture to Mr. Fate, in this infected area, embracing the towns of Greenwich (36 infected trees), Stamford (9), Darien (8), Norwalk (1) and Fairfield (2). However, in the last town we failed to obtain cultures from the two young trees reported there, though at least three attempts were made from one of them but always with negative results so far as *Graphium Ulmi* was concerned.

With the single old tree found outside of the area in Fairfield County located by the station's scouts—namely, about 50 miles distant at Black Hall, Old Lyme—not only were cultures obtained from the twigs, the old diseased bark and the wood (later verified by the U. S. Department of Agriculture), but also the fruiting stage of the Graphium was found more abundantly in the dead bark than in any other tree in Connecticut to date. The foreign beetle carrier, *Scolytus multistriatus* Marsh, was not present in this tree or apparently in its general region. However, a native beetle and its larvae, *Hylurgopinus rufipes* (Eich.), determined by the station's entomological department, was present.

These two stages of Hylurgopinus and mites, also present, were found to be local carriers over the infected bark, since all of them taken from the bark were able to transfer the Graphium to media in Petri dishes. Furthermore, the mature beetles were found to be possible carriers of the disease to healthy trees, since when placed in test-tubes with healthy twigs of elm the latter became infected the same as has been shown before with *Scolytus multistriatus*, the common carrier here.

The Hylurgopinus beetles for this experiment were taken from the infected bark in the Old Lyme tree and carried in bottles to New Haven and then placed in test-tubes with local healthy elm twigs that had

been previously sprayed with alcohol and burned to kill most of the adhering spores of saprophytic fungi. In some 20-odd cases in different tubes, the coremial stage of *Graphium Ulmi* appeared on at least 75 per cent. of the twigs. In about a dozen different tubes, where such beetles from dying elms not killed by the Graphium were used, the fungus did not appear on any of the twigs. This does not mean, however, that such beetles might not carry the disease from diseased trees to those dying from other causes.

Our experiments, however, indicated that the *Hylurgopinus rufipes* is a probable carrier in nature. How much this beetle injures the young twigs in the early season we do not know, but in our experiments the beetles chewed the bark and even at times entered somewhat out of sight in the twigs. It is, however, up to the entomologists to show what injury this beetle does to the elm twigs in the early summer. It is also up to them to demonstrate how commonly beetles go from infected trees to those dying from other causes. If this can be shown as a common occurrence, then there is a more definite reason for getting rid of such non-infected trees, as far as control of the fungus is concerned. In Europe besides *Scolytus scolytus* and *S. multistriatus, S. sulcifrons* has recently been claimed as a carrier of *Graphium Ulmi* to elms in Italy.

The station's scouts, in the state outside of the infected area in Fairfield County, reported over 50 dead or dying elms showing tunnels of either Hylurgopinus or Scolytus. We examined practically all these, and as many more with or without beetle tunnels, for indications of *Graphium Ulmi* in the dead bark, but in no case was this found. However, we did find in some of them a saprophytic Graphium, with spores finally dark in mass, and in one or two cases what seemed to be the immature asco stage of it. So far the asco stage of *Graphium Ulmi* has not been found in nature in this state; however, in cultures, imperfect developments of it have been seen rarely in certain test-tubes.

This survey of dead elms is valuable in what it may show later when *Graphium Ulmi* invades this free territory. A less extensive but similar examination in the infected Greenwich-Stamford area also failed to reveal the fruiting stage of *Graphium Ulmi* on the dead or dying bark of elms dying from other causes. Both inspections were made about the same time in the fall. Further observations, however, need to be made before we can be sure of the value or uselessness of removing dead trees or limbs, dying from other causes, as a means of limiting the direct spread of *Graphium Ulmi.*

We have been able in a fair number of the cases tried to produce the coremial stage of *Graphium Ulmi* by spraying pure cultures of the spores on the inner bark of the elm in moist chambers. So far, apparently, the healthy bark has given better results, though we have had some infections on beetle-injured, rotting bark.

Dr. L. B. Arrington was temporarily hired for superintending the tree survey work for the station and proved very satisfactory. All the infected trees found in Connecticut have been removed and destroyed. This eradication has been done under the direction of W. O. Filley, the station forester. Just how effective this apparently complete control work has been remains to be seen when possible new or undiscovered infections show next summer.

G. P. CLINTON
F. A. MCCORMICK

CONNECTICUT AGRICULTURAL EXPERIMENT STATION

THE BELGIAN NATIONAL RESEARCH COUNCIL

AT a time when the support of scientific work and the place of science in national planning is a subject of discussion, the sixth annual report of the Belgian *"Fonds National de la Recherche Scientifique"* is especially interesting. This foundation, with a capital of approximately $6,000,000, was started in 1927 by contributions from many private and industrial sources under the enthusiastic support of the late king. To form an estimate of the relative importance of the foundation, the reader should multiply the figures in this review by fifteen, the ratio of the populations of the United States and Belgium. Of the income of $350,000 in 1933, about half was devoted to subsidies in aid of pure scientific and scholarly investigations (philosophy and letters as well as law are included). The industries were, however, not neglected, as grants of $55,000 were also made in aid of twelve projects. In general the foundation expected the industry interested to contribute half of the cost of the investigation on the theory that "a business man is apt to think that what costs him nothing is not worth much."

The $175,000 devoted to pure science was distributed in a manner that has many novel features. Forty per cent. or $70,000 was given for the equivalent of our national research fellowships. These fellows, 68 in number, are appointed for two-year periods, which are renewable up to six years. The stipend increases from $1,000 to $1,200, and the number of fellows shows a gradual and natural decrease for successive years of tenure (20, 16, 12, 8, 8, 4).

The policy guiding the foundation is stated as follows: "To endeavor to assure the continuity of scientific effort in our country, and to provide for the

recruiting and development of the personnel in advanced teaching and research positions." The support of selected fellows for long periods at a low stipend undoubtedly favors the gradual and natural absorption of these men into the various institutions of the country. How often have we seen a young man come to the end of a two-year fellowship with an investigation well under way, and then, for financial reasons, accept some position where his scientific work must be dropped!

The novel features are still more striking in the disposition of the remaining 60 per cent. of the funds. Subsidies amounting to $28,500 were granted to 23 "associates." These "associates" are men of an established scientific reputation who are on the regular staffs of universities or institutes, the subsidy allowing them to go on a "part-time" basis, so that they may have time and energy to continue their investigations. The total salary, however, is never allowed to exceed that of their colleagues on a full-time basis. In this way the foundation endeavors to counteract some of the undesirable results of the system of regular routine promotion and emphasis on teaching which has ruled in the Belgian universities.

Partly due to the policy of the Fellowship Board of the National Research Council, we have tended to concentrate scientific work in a few institutions. This is doubtless a wise policy in dealing with young men who gain very much from association with a group of active co-workers. But science can not exert the proper influence on the educational life of the country if it is confined to a few research institutes. It is easy to imagine the effect of a policy such as that followed by the foundation with its "associates," in giving prestige to serious, scholarly and scientific work in all the institutions of the country and weaning them gradually from contentment with lesser ideals.

A third category contains subsidies to investigators "who have won distinction by their scientific work." Thirty-two received $25,300 for financial assistance in carrying out various investigations; $10,400 was distributed to 32 applicants for expenses in traveling and visiting laboratories in different countries, and $10,000 was used in paying technical assistants for 13 scientists.

In addition, apparatus costing $26,500 was purchased and loaned to various investigators. This apparatus remains the property of the foundation which, as the result of purchases in preceding years, now has at its disposal apparatus valued at $160,000.

The foundation also provides annually a sum of $31,250, which is devoted to paying life annuities, not exceeding $1,250 each, to certain distinguished scientists, selected apparently on the basis of the prizes and honors that have been awarded to them. As the report explains: "The council considers it its duty to create for certain particularly eminent men of science a position worthy of the rôle that they play in the moral and material development of the country." The recognition of such a group probably emphasizes the diversified character of scientific advance and the fact that constant effort is called for on all fronts.

It is apparent that in Belgium the national importance of sustained scientific work and the continuous selection and development of able men in the institutions of the country is vividly realized, and measures are being taken which far exceed in relative magnitude any analogous ones in our country.

A. J. DEMPSTER

UNIVERSITY OF CHICAGO

OAK TREES AND THE WHITE GRUB MENACE

THE southern half of the state of Wisconsin is characterized by an oak-hickory climax forest. This area coincides closely with the estimated areas of severe grub damage to pasture and corn land. Further, most of this injury is caused principally by the grubs of four species of June beetles which have a marked preference for certain varieties of oak, notably bur oak. It would appear that a correlation exists in nature between the abundance of certain injurious species of white grubs and certain preferred adult food plants.

In the choice of trees for propagation, either on a small scale or on a gigantic scale such as the U. S. Shelter Belt project, each variety should be considered in relation to its relative attractiveness as June beetle food not only from the standpoint of the successful establishment of the young trees but also from the standpoint of the possible associated increase of harmful insects, such as white grubs. The same extremely harmful species of June beetles so abundant in Wisconsin which have predominant oak feeding preferences are now present in small numbers in at least part of the area to be crossed by the proposed shelter belt. If conditions are made more favorable for these and other pests future farmers may face conditions just as serious as drought.

C. L. FLUKE, JR.
PAUL O. RITCHER

UNIVERSITY OF WISCONSIN

THE BIOLOGY OF THE BLACK WIDOW SPIDER, LATRODECTUS MACTANS[1]

DURING the past three years the writers have made numerous collections of the black widow spider in Ravalli County, Montana. During this period there

[1] Contribution from the Rocky Mountain Laboratory of the U. S. Public Health Service, Hamilton, Montana.

has been a continuing infestation in the main buildings and outbuildings of the Rocky Mountain Laboratory of the United States Public Health Service at Hamilton, and the spiders have been occasionally found in residences within the city. However, they have been most frequently met with in the burrows of the Columbian ground squirrel, *Citellus columbianus*.

During the spring and summer the spiders are found in or at the margin of irregular webs stretched across the openings of the ground squirrel burrows, especially of those which are deserted. When disturbed they retreat to the walls some distance back from the opening. This habitat is favorable because of rather plentiful and constant insect fauna which is associated with the underground tunnels and nests.

The underground conditions are also well suited for successful hibernation, since the burrows extend below the usual frost line. During the excavating of squirrel nests in November and December, 1932, after the surface soil was frozen, spiders were found deep in the burrows. Immature specimens, as well as males and females, were found in the tunnels and nests.

This spider has also been encountered in abundance in the semi-arid, unirrigated bench lands of the Yakima Valley in Washington, where characteristic webs, egg cases, spiderlings and females were found in the openings of abandoned warrens of cottontail rabbits.

These observations suggest that rodent burrows form an important natural habitat for the breeding and hibernation of *Latrodectus mactans* in the northwestern states.

WM. L. JELLISON
C. B. PHILIP

A NEW SOUTH DAKOTA METEORITE

THE South Dakota State School of Mines recently came into possession of an iron meteorite found in the spring of 1934 on the W. L. Dale ranch located at the head of Black Pipe Creek in northeastern Bennett County, South Dakota. The specimen was unearthed by a farm helper while disking a field in planting corn. The field had been cultivated for several years, and nothing unusual had been observed. The disk struck the meteorite, the impact producing a peculiar sound and this led to investigation, including some digging. The conditions were much as might be expected in connection with any field stone, and there were no observable signs of the meteorite having fallen recently. The specimen was found in the northeast corner of the southeast quarter of section 32, township 33, range 39. This is approximately 35 miles northeast of Martin, the county seat of Bennett County, and 10 miles south and 3 miles west of the post office of Norris.

The meteorite, designated as the Bennett County meteorite, is a smooth, compact, irregular saddle-shaped mass 16 inches (407 mm) long; 12 2/3 inches (321 mm) wide; and 10 1/2 inches (267 mm) high in the highest part, measured perpendicular to the somewhat flat base. Its weight as found was 195 pounds 11 ounces. Much of the surface is pitted. A considerable part of it has a smooth, somewhat shiny and nearly black surface, while other parts, particularly the base, is largely covered with a brownish-yellow oxidized coating. An analysis of unoxidized drillings shows the contents as follows: iron, 94.26 per cent.; nickel, 5.25 per cent.; cobalt, 0.46 per cent.; sulphur, 0.04 per cent. The analysis does not indicate carbon, but microscopic examination discloses occasional small particles of graphite. In addition to the nickel-iron alloys polished surfaces reveal numerous small inclusions of triolite. Some of the triolite is in the form of nodular inclusions and some of it in thin veins. Polishing and etching reveal coarse Widmanstatten figures, but further study of the structure is necessary before the meteorite can be definitely classified as to type.

CLEOPHAS C. O'HARRA
SOUTH DAKOTA STATE SCHOOL OF MINES

GROUND WATER AND FOREST BELT

PROFESSOR H. J. LUTZ, of the School of Forestry, Yale University, has kindly called my attention to an error in the statement of one of the illustrations used to emphasize the importance of a sound basis of scientific knowledge as prerequisite to any proper program of national planning in respect to natural resources.

On page 390 in SCIENCE for November 2, 1934, I stated:

> Again, scientific study has recently shown that, if the number of trees per acre is reduced below a certain minimum in the yellow pine belt just east of the Cascade Mountains, then the ground water level drops and the country becomes a desert.

It is well known that the ground water level is lower beneath a forest than it is under most other types of vegetation. The effect of cutting a forest is not in general to lower but to raise the water table. I am informed that the natural spread of the forest belt east of the Cascades in central Oregon is initially promoted not by a favorable change in the ground water but because of an irregularly recurrent increase in surface moisture which provides both seeds and seedlings especially favorable opportunities for growth.

KARL T. COMPTON
THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SCIENTIFIC BOOKS

INFANT BEHAVIOR

Atlas of Infant Behavior: A Systematic Delineation of the Forms and Early Growth of Human Behavior Patterns. By ARNOLD GESELL. Vol. I—Normative Series, in collaboration with Helen Thompson, and Vol. II—Naturalistic series, in collaboration with Alice V. Keliher, Frances Lillian Ilg and Jessie Jervis Carlson. 921 pages. Yale University Press, New Haven, Conn. 1934. $25.00.

IN these well-planned and extraordinarily well-printed volumes, Arnold Gesell, who for three decades has pioneered in research on the infant and young child, presents thirty-two hundred photographs, enlarged from motion picture frames, delineating the behavior of infants during the first year of life. Those in the first volume, taken in the photographic dome of the Yale Psycho-Clinic under laboratory conditions, show the development of 24 behavior sequences which cover posture, locomotion, perceptual, prehensive and adaptive behavior at 4, 6, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48 and 52 weeks, respectively. For instance, there is a series of photographs showing the behavior of an infant while sitting, another showing stair climbing, another showing behavior in the ring and string situation.

The enlargements in the second volume show the behavior of infants in naturalistic situations—*i.e.*, under a duplication of home conditions, in a special studio room to which both the infant and the mother, who was present, have been habituated. One purpose of the second volume is the portrayal of individual differences in development. The behavior situations and episodes illustrated center about feeding, bathing, posture, social behavior, play and locomotion. Each volume contains a description of the methods of securing and treating the films and of the apparatus, cameras and observation chambers used. Each photograph in a sequence is accompanied by a brief verbal description and is timed—*i.e.*, the time elapsing from the beginning of the particular response is stated.

In the first volume the pictures are arranged by behavior patterns in age sequences; in the second volume by children. Both volumes are loose-leaf with the photographs printed on only one side of the page to facilitate rearrangement for cross comparison in accordance with the reader's interests. Thus all the pictures dealing with the development of eating or bathing habits can be put together. The excellent quality of the enlargements in the first volume is exceeded by those of the second volume—indicating the superiority of 35 mm over 16 mm film.

The approach to the study of infant behavior as presented in the atlas is so new that its evaluation is difficult. There is no doubt of its vivid and striking portrayal of infant behavior and its worth for teaching and demonstration and for directing the attention of scientists, students, parents, artists and other workers to various aspects of infant development. Only the future can determine its scientific value. The statistical data necessary for the interpretation of the normative and naturalistic pictures are not given. Nor is it clear how a particular picture or sequence was selected as normative. On the other hand, taken as a whole, rather than examined critically in detail, the sequences give a graphic and total picture of development that may for some purposes be of more value than the fractionating of behavior into minute parts to which we have become so accustomed.

Gesell states (p. 41) that the atlas is offered as "a systematic collection of specimens of infant behavior patterns," and goes on: "In format, arrangements, and mechanical makeup both volumes are designed to make this collection useful for conducting both analytical and comparative studies. Interpretive comment is withheld and the course of the behavior alone is described." The atlas therefore presents the material from which scientific conclusions may be drawn without itself actually generalizing. This raises an interesting question. Is the description of behavior in verbal terms or with the aid of fine instruments, such as the cinema, any more than the presentation of raw data? A partial answer is found in the fact that the pictures presented in the atlas were selected by one of the outstanding students of infant behavior from millions of cinema frames available in the Yale Psycho-Clinic. In the introduction to the atlas, Gesell mentions another publication, entitled "Infant Behavior: Its Genesis and Growth,"[1] which contains an exposition of the findings of the normative research and which he says may be used as a detailed handbook for the interpretation of the illustrations in the atlas.

JOHN E. ANDERSON
UNIVERSITY OF MINNESOTA

MATHEMATICAL PHYSICS

Principles of Mathematical Physics. By WILLIAM V. HOUSTON. Pp. xi + 265. McGraw-Hill Book Company, Inc., 1934.

THIS book is a text of intermediate grade designed to give the college student specializing in physics a working knowledge of the fundamental methods of mathematical physics, without attempting any elaborate exposition of physical theories. A thorough knowledge of elementary physics on the part of the

[1] Arnold Gesell and Helen Thompson, "Infant Behavior: Its Genesis and Growth." McGraw-Hill. New York, 1934. 343 pages.

student and a familiarity with analytical geometry and calculus is assumed.

Subjects treated include mechanics, thermodynamics, electricity and magnetism, together with a short discussion of the special or restricted theory of relativity. Mechanics is emphasized not only because it furnishes fundamental concepts for all other branches of physics, but also because its development provides examples of a number of important mathematical methods. The treatment of Hamilton's principle and the discussion of Gibbs's statistical mechanics, in particular, although not elaborate, are very satisfactory. On the other hand, more space could well be devoted to thermodynamics, and the same is true to a less extent in connection with the portions of electricity and magnetism dealing with material media.

In addition to the above, chapters are devoted to differential equations, calculus of variations and vector analysis. The treatment of these subjects, although compact, is clear and should be very useful to the student of physics with only the average preparation in mathematics. No attempt is made to develop any of the various subjects in great detail, much being left to the student in the form of problems, of which there are a large number. For those interested in collateral reading an excellent list of references is appended to each chapter.

The most serious defect in the book is the almost entire lack of figures. There are but three altogether, although at many points a figure would undoubtedly be an aid to the student's comprehension of the analysis.

"Principles of Mathematical Physics" should prove satisfactory as a basic text in a lecture course introducing mathematical physics and also should be of value as an auxiliary in more advanced courses, particularly in the field of mechanics, as there are a number of items included here which are often omitted from other texts. The book is not well suited, however, to independent study by the average student, as supplementary physical background should be supplied in many places.

N. I. ADAMS, JR.

YALE UNIVERSITY

SCIENTIFIC APPARATUS AND LABORATORY METHODS

INTRATRACHEAL INOCULATIONS IN THE RAT[1]

As a preliminary step in the study of lobar pneumonia in the rat, the following method of intratracheal inoculation has been developed.

The anesthetized animal is placed on its back with the head at the edge of the table and held by an assistant, who grasps the tongue with a hemostat. Traction is applied to the tongue so that it is held firmly to the side of the mouth and against the lower teeth. The root of the tongue is raised by spreading the blades of a curved hemostat inserted far back in the pharynx and held by the operator. The field is illuminated by reflected light from a head mirror. Under direct vision a specially devised cannula may then be inserted into the trachea.

The cannula is made of brass tubing 7 cm long, 2.5 mm outside diameter and 1.6 mm inside diameter. The tube is bent upward at an angle of 15°, 0.5 cm from the distal end. The tip is beveled on the upper surface, care being taken to avoid sharp edges. Near the proximal end of the tube a brass rod 5 cm long and 3 mm in diameter is soldered at right angles to serve as a handle.

To enter the trachea, the beveled tip of the cannula is placed just under the epiglottis, which is then raised slightly. The handle of the instrument is depressed and the cannula passed gently into the trachea. When the cannula is in the trachea a drop of soap solution placed over the proximal end will form soap bubbles which break explosively. If the cannula has entered the esophagus bubbles may form but do not break with expiration. This test is important.

In the final step of the procedure a No. 5 French ureteral catheter (1.5 mm in diameter) is passed through the lumen of the cannula and withdrawn 0.5 cm at the first sense of resistance. This serves to free the tip of the catheter. Up to 0.5 cc of material may be injected from an attached syringe.

After an experience of over 300 inoculations made by this method, it is believed that with limited practise one should be able to make successful inoculation in at least 95 per cent. of the trials. Guinea pigs may also be inoculated by this method, although greater difficulty is encountered in passing the cannula into the trachea.

L. JOURDONAIS
W. J. NUNGESTER

[1] From the Department of Bacteriology, Northwestern University Medical School, Chicago, Illinois. Aided by a grant from the American Medical Association.

THE PRESERVATION OF CARTILAGE

THIS technique was evolved to obviate certain difficulties in handling the cartilaginous structure of a chimaeroid fish, *Hydrolagus colliei* (Lay and Bennett). In this case the cleaned cranium was dehydrated by ordinary histological methods. After it had been placed in paraffin, the temperature of the

paraffin was raised until it was quite liquid, and then the cranium was removed and wiped clean. At the present the cranium has been exposed to such desiccation as would occur on my desk for quite some time, and there is absolutely no sign of shrinkage or alteration. This process would be applicable to the cartilaginous structure of any of the smaller elasmobranchian fishes, for there is an evident limit in the size of the cartilage to be impregnated; although the degree of infiltration necessary to preserve the cartilage would be below the standard required in microtechnical work. The cranium is in a condition for study far superior to cartilaginous material in liquid preservatives.

V. BROCK

STANFORD UNIVERSITY

PERMANENT ACETO-CARMINE PREPARATIONS

THE following method has proven useful in accurately and permanently preserving the cytological details in aceto-carmine preparations. It is rapid and convenient and has been found more satisfactory for our purposes than previous techniques.[1]

The preparation is made in the usual way[2] and sealed with vaseline or preferably paraffin. When the stain is satisfactory the slide is supported face down by two thin glass rods in a petri dish of a mixture of equal parts of xylol, absolute alcohol and glacial acetic acid until the cover soaks loose. The action of the reagent is hastened by first cracking off most of the paraffin seal with a needle and also by gentle agitation of the slide.

When the cover comes off (5 minutes to ½ hour) the slide is rinsed in the solution for 5 minutes, drained carefully and wiped free from mounting medium. It is then passed through two changes of a mixture of equal parts of xylol and absolute alcohol (5 to 10 minutes each), then through xylol (10 to 15 minutes) and mounted in balsam. The xylol stage may be omitted with minute objects such as pollen-mother cells. Occasionally part of the preparation adheres to the cover slip in which case cover and slide are run up separately and recombined in balsam. Preparations in the balsam improve in clarity for a week or more. Smears of pollen-mother cells (*Lilium, Podophyllum, Hyacinthus, Tulipa*) made in this way are unaltered 10 months after preparation. The method has been used successfully on smear preparations of Dipteran salivary glands (*Drosophila, Sciara,* blowfly).

Professor C. W. Metz and Miss Elizabeth Gay find the following modification equally as good as the above for paraffin-sealed smears of *Sciara* salivary glands: Soak off the cover in equal parts of 95 per cent. alcohol, clove oil and glacial acetic acid; 2 changes of 95 per cent. alcohol up to ½ hour; absolute alcohol 5 minutes; clove oil 10 minutes; xylol 5 minutes; balsam.

JOHN B. BUCK

ZOOLOGICAL LABORATORY
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SPECIAL ARTICLES

THE SIMILARITY BETWEEN FASCIATIONS IN PLANTS AND TUMORS IN ANIMALS AND THEIR GENETIC BASIS

A COMMONLY recurring abnormality in plants is the irregular development of the growing points of the main stem or branches called fasciations. These peculiar formations occur in many plant families and are particularly noticeable in species having an indeterminate type of growth. In some cases fasciated plants are able to reproduce and all the progeny show the same abnormality. In these cases the teratological development is due to one or more specific genes for abnormal growth and is definitely inherited. In many other cases fasciations occur only in one part of a plant. Such variations occur so sporadically both in seed and vegetatively propagated plants that they seem not to have any basis in inheritance, yet they appear more frequently in some germinal lines than in others. Gall formations occur in plants, and many of these are clearly due to insect, fungus and bacterial parasitism. In some galls no infection can be found and these seem to be a form of unregulated growth for which no adequate explanation has been made.

The tumors in animals that assume many different forms and occur in many parts of the body are also a form of unregulated growth. This abnormal development frequently starts in traumatic tissue. In both plants and animals the injurious nature of unregulated growth comes mainly in later stages from a breaking down of cells due either to pressure or to a failure of normal metabolism, resulting in secondary infections in necrotic tissue. Plants differ from animals in that there is no migration of abnormal cells to other parts of the organism starting new centers of growth. In plants there is no circulatory system whereby this transfer could be brought about. Fasciations and galls in plants do not show the malignant features characteristic of many tumors in animals.

[1] B. McClintock, *Stain Tech.*, IV: 53, 1929; W. C. Steere, *Stain Tech.*, VI: 107, 1931.

[2] Lee, "Microtomist's Vade-Mecum," p. 142, 9th ed., 1928; J. Belling, *Am. Nat.*, 55: 573, 1921; *Biol. Bull.*, 50: 160, 1926.

Other differences in atypical growths in plants and animals arise from fundamental differences in development.

There are many transmissible lethal factors in both plants and animals that stop development at an early stage of embryonic growth when homozygous. In plants there are the numerous defective and germinating seeds that appear when naturally cross-fertilized species are self-fertilized. In some cases growth is stopped immediately after fertilization. In other cases the embryo and endosperm develop in a mass of abnormal tissue that finally breaks down and the resulting abnormal seeds fail to germinate. In many cases the embryos fail to go into their normal resting condition in mature seeds but keep on growing until they finally die with the maturity of the plant upon which they are borne. In animals there are lethal factors that result in the death of the embryo at various stages of development. In some cases the abnormal embryos survive birth resulting in monstrous forms. Not all these are due to single or multiple inherited genes, but many cases have been proved.

An individual heterozygous for these recessive genes may be normal throughout its entire life. But if anything should happen to the chromosome carrying the dominant allele, whereby the protecting gene is lost, abnormal development would be expected under certain conditions. If the change takes place in a critical place the death of the organism might result before the unregulated growth could attain a visible form. In many places unregulated growth would be held in check by surrounding tissues. But there are undoubtedly many places where there are actively dividing cells, and abnormal development starting from them could reach considerable proportions before serious injury resulted. An important point that seems to have gone unnoticed is that genes acting in restricted localities in somatic tissue may have an entirely unrecognized effect as compared to their action in embryos.

In plants unregulated growth can start only in the cambium and in growing points. In the first case the result would be gall formations and in the second, abnormal roots, stems, leaves or flowers which we see in fasciations. In animals similar growths could occur at many places where there are dividing cells. Particularly likely places would be in glands and in regenerating tissues resulting from injury.

Recent cytogenetic investigations have shown various ways in which recessive genes are allowed to appear in somatic tissue due to deletions, non-disjunction and other chromosomal aberrations. Any irregularity whereby a whole or part of one member of a chromosome pair is lost allows the latent genes in the corresponding chromosome to appear, provided there is enough subsequent growth from the deficient cell to become visible. Variable patches of colored aleurone in maize due to deficiency have been noted with a frequency of one in 30 seeds in some families and none in others. These frequencies fluctuate widely. Color variations in vegetatively propagated fruits and flowers are brought about in the same way. In many different animals mosaics of this type have been noted. These variations may be classed as somatic segregations due to *hemizygous* genes, that is, loci of which the corresponding section in the other member or members of the chromosome set is missing. In this way recessive genes become visible.

It is known also that missing segments may have a visible expression in modified characters as a direct result. Thus Notch wing in Drosophila results from a deficiency in the facet region. In this case the variation is not due indirectly to the uncovery of a recessive gene but directly to a loss of chromatin. Since somatic segregation occurs with a high frequency due to the uncovery of recessive genes resulting from a deletion in one chromosome there is the probability of a deletion in corresponding sections of two homologous chromosomes as a chance occurrence. This results in genes that are completely missing. A similar situation follows a viable deficiency in one chromosome and non-disjunction in the homologous chromosome, as shown by Demerec and by Ephrussi.[1] There is therefore the possibility that missing genes due to corresponding deficiencies in certain parts of both members of a chromosome pair result in a chromosomal unbalance and this brings about unregulated growth. Atypical growth in maize has been found associated with chromosome irregularities.

A most significant fact is found in the action of tar and aniline dyes. It has long been known that these substances induce abnormal development in animals in some cases and not in others. It has recently been found that the active principle of crude tar is dibenzanthracene. One of the noticeable effects of this substance when injected into living tissue is to bring about non-disjunction of chromosomes. Many other cancer-producing substances have a similar effect on chromosomes as well as x-rays and radium. If this induced chromosome aberration acts indirectly through the manifestation of hemizygous recessive genes or the total loss of genes necessary for normal growth or directly as a result of chromosome unbalance in particular regions we can understand why unregulated growths occur sporadically but with higher frequencies in some families than in others.

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1 *Proc. Nat. Academy of Sciences*, 1934.

MOTTLED ENAMEL OF DECIDUOUS TEETH

MOTTLED enamel,[1] which we now know to be caused by the poisonous action of fluorine which is present in the water supply of the afflicted persons in the concentration of 1 part per million or above, has been considered primarily a defect of the second or permanent set of teeth. In 1916 McKay[2] said, "Mottled enamel in my experience has never been found upon the temporary teeth." Later, in 1932,[3] McKay modified this statement somewhat to say that "the temporary teeth have been found to be affected very rarely and then only the molars and *very slightly.*"

The writers have personally examined the teeth of thousands of children in Arizona to determine the incidence of mottled enamel and in 1931[1] stated that "deciduous teeth more rarely show mottling, mottling being chiefly a defect of the permanent teeth, although a few cases on the temporary molars of Indian children have been observed." The explanation given for the almost complete absence of mottled enamel on temporary teeth was that in all probability fluorine in sufficient concentration did not pass through the maternal placenta, and hence the deciduous teeth, which were formed and largely calcified before birth, were spared.

It is the purpose of this note to report the occurrence of severe mottled enamel upon all the deciduous teeth of children in a community recently visited by the authors. The first cases noted were those of two sisters, aged 5 and 7, respectively. The condition of the temporary teeth was too severe to be considered typical of mottled enamel. The teeth did not show chalky white areas characteristic of mottled enamel, because most of the enamel was gone. The premolars were ground off almost down to the gum line. The parents of these girls had repeatedly sought dental advice, but the condition had completely baffled the dental profession. A Wassermann test had shown the absence of venereal infection. Analysis of the private well water supply of this family showed a fluorine content of 12.0 parts per million, as determined by the Foster method of analysis, by means of which 1 part per million has been established as toxic level.[4]

Subsequently, other cases of the same severe type of mottled enamel on the temporary teeth have been observed in the same general district. In each case, analysis of the water supply has revealed an extremely high fluorine content (from 12 to 16 parts per million). The fluorine concentration of the water in this district is higher than any reported heretofore.

In spite of the fact that deciduous teeth are largely calcified before birth and have a relatively short period of both prenatal and postnatal development, it would appear that use of water containing excessively high concentrations of fluorine during the period of their formation produces mottled enamel of an extremely severe type on the temporary teeth.

It is interesting to note also that mottled enamel of the permanent teeth has been observed in persons who had not used this high-fluorine-water for drinking, but had used it for cooking and other household purposes only.

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AUGUST, 1934.

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THE DISINHIBITION OF EXPERIMENTAL EXTINCTION IN THE WHITE RAT

THE phenomenon of the disinhibition of experimental extinction, described by Pavlov for the salivary reflex, is an important characteristic of behavior because it throws light on the conditions which control behavior. The terms inhibition (as exemplified in experimental extinction) and disinhibition refer primarily to the respective non-appearance and appearance of behavior under certain well-defined conditions. Just what the physiological processes concerned may be is still undetermined. It may well be that the phenomena described by Pavlov are quite different physiologically from the other inhibitory phenomena studied by physiologists. Leaving this question aside, however, it is still important to verify Pavlov's findings with the salivary reflex by experiments on such a laboratory animal as the white rat using overt bodily activity of the locomotor type.

The present note reports two experiments. In the first experiment, 4 normal untrained white rats of about 3 months of age were conditioned to a light. This response was then extinguished by withholding reinforcement; after which a buzzer was sounded at medium intensity at the moment when the light should have been presented. When the light was used one minute later, disinhibition was assumed if the rat now responded to the light. The second experiment was conducted with three other normal untrained white rats. In this case the rats were first conditioned to the sound of the buzzer; the response was then extinguished; and the effect of the light as a disinhibiting stimulus was then tested. The buzzer and the light were the same in the two experiments.

The apparatus used was developed in the Clark Laboratory some two years ago as a modification of

one described by Warner.[1] An essentially similar device has been independently developed and reported by Culler, Finch and Girden.[2] In the present apparatus the rat stands on a grill through which an induction current can be sent. In response to the shock, the rat runs in one direction or another along a narrow pathway. The buzzer used in the conditioning was placed over the center of the apparatus. The light used was furnished by two 100 watt bulbs so hung that the apparatus pathway in which the rat ran was essentially uniformly and brilliantly lighted. Throughout the work there was constantly present a low diffused illumination from a small light placed beneath the milk glass plate on which the apparatus stood. The entire apparatus was placed in a relatively soundproof double box through whose window the rat's behavior was observed. It was arbitrarily decided that the rat's response must equal a run of at least a body length before a response was to be counted. This all-or-none standard, although arbitrary, was based on experience and in actual practise proved satisfactory. A synchronous motor timer made possible the automatic presentation of the buzzer and shock stimuli. The buzzer sounded at one minute intervals. Two seconds after the buzzer, a shock was given the rat if no adequate response to the buzzer had been made. No shock was given if an adequate response was made within 2 seconds to the buzzer. Where the light was used either as a conditioning or as a disinhibiting stimulus, its presentation was timed by the clock, but its switch was manually operated. Otherwise the conditions were the same as they were where the buzzer was used.

The 4 rats who were initially conditioned to the light stimulus required 10, 10, 23 and 27 minutes, respectively, for this conditioning before they reached the stage where they would respond 10 times in succession. They required 72, 43, 66 and 74 minutes, during which the light was presented once a minute without reinforcement, before experimental extinction was established to the point where no response was made for 10 successive presentations of the light. At this point, in place of flashing the light, the buzzer was sounded once. No response was made to the buzzer; but when, one minute later, flashing of the light was again resumed at one-minute intervals without reinforcement, one rat responded 3 times to successive lights, one rat did not respond until the third flash, whereupon 6 successive responses were made, one rat responded on the third and fourth presentations of the light, and one rat failed to respond to the first three presentations. When the new (disinhibited) responses to the light were again extinguished to the point where the rats made no response for 5 successive presentations of the light, the buzzer was again sounded once. All four rats then immediately responded to the light for 2 or 3 presentations before extinction again appeared. The above tests were made at one experimental session per rat. Twenty-four hours later in 3 cases and 72 hours later in one case, the rats were again conditioned to the light, if necessary, to the point where they made 10 successive responses to the light; the response was again extinguished to 10 successive failures to respond; and the buzzer was used for disinhibition. Positive results of the above type were secured for all animals.

The 3 rats who were initially conditioned to run to the sound of the buzzer required 29, 17 and 10 minutes, respectively, before they responded 10 times in succession. They required 66, 58 and 54 minutes for experimental extinction of the response, during which time the buzzer sounded regularly at one-minute intervals, the standard of extinction being 10 successive failures to respond. Three, 9 and 10 days later, respectively, the rats were again conditioned to the buzzer, and again the response was extinguished. In the two series of tests, the light was used 9 times as a disinhibiting agent, used precisely as the sound had been used in the first experiment. In 6 of the 9 cases, the light clearly disinhibited the experimental extinction of the conditioned buzzer response, giving the same type of results as were described above where the buzzer disinhibited the extinguished light response. In the other 3 cases no evidence of disinhibition was present.

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